

CLAIMS

1. A method of forming a sealed female fastener and panel assembly, said female fastener including an annular pilot portion having an annular end face, a bore extending through said pilot portion through said end face, an annular flange portion
5 surrounding said pilot portion having an annular end face parallel to said end face of said pilot portion, and an annular groove in said flange portion having a bottom wall and relatively inclined side walls including an outer side wall and an inner side wall inclined radially outwardly from adjacent said bottom wall, said method comprising the following steps:

10 driving an annular lip of a die member against a panel engaging said annular end face of said pilot portion, said annular lip having an inner diameter less than an outer diameter of said annular end face of said pilot portion and an outer diameter less than an inner diameter of said outer side wall of said annular groove, thereby piercing a slug from said panel having a diameter less than said outer diameter
15 of said annular end face of said pilot portion and forming an opening through said panel;

continuing to drive said annular lip of said die member against a panel portion surrounding said opening in said panel and against an outer periphery of said annular end face of said pilot portion, thereby shaving an annular outer portion of said
20 pilot portion against an inner portion of said panel portion; and

continuing to drive said annular lip of said die member against said panel portion and said annular outer portion of said pilot portion and deforming said pilot portion against said bottom wall of said annular groove, thereby deforming said panel portion radially inwardly and outwardly entrapping said panel portion in said
25 annular groove and sealing said female fastener on said panel.

2. The method of forming a sealed female fastener and panel assembly as defined in Claim 1, wherein said outer side wall of said annular groove is inclined radially inwardly and said panel portion is integral with a remainder of said panel, said
30 method including deforming said panel portion radially outwardly beneath said inclined outer side wall of said annular groove.

3. The method of forming a sealed female fastener and panel assembly as defined in Claim 2, wherein said outer side wall of said annular groove is arcuately inclined radially outwardly, said method including deforming said panel around said arcuately inclined surface of said outer side wall of said annular groove.

5

4. The method of forming a sealed female fastener and panel assembly as defined in Claim 1, wherein said method includes shaving a cylindrical surface of said pilot portion extending from said annular end face of said pilot portion to said annular outer portion of said pilot portion and forming an arcuate portion engaging and entrapping said pilot portion.

10

5. A method of forming a sealed female fastener and panel assembly, said female fastener including a generally cylindrical pilot portion having an annular planar end face, a bore extending through said pilot portion through said annular planar end face, an annular flange portion surrounding said pilot portion having an annular end face parallel to said end face of said pilot portion, and an annular groove in said flange portion having a bottom wall and relatively inclined side walls including an outer side wall inclined inwardly from said bottom wall toward said pilot portion and an inner side wall inclined radially outwardly from adjacent said bottom wall toward said flange portion, said method comprising the following steps:

15

20

driving an annular lip projecting from a die member through an opening in a panel supported on said annular end face of said flange portion, said annular lip having a generally planar annular end face, a generally cylindrical inner surface having an inner diameter less than an outer diameter of said annular end face of said pilot portion and an outer diameter less than an inner diameter of said outer side wall of said annular groove;

25

continuing to drive said annular lip of said die member against said annular end face of said pilot portion and an annular panel portion surrounding said opening in said panel, thereby shaving an annular outer portion of said pilot portion against said panel portion; and

30

continuing to drive said annular lip of said die member against said outer portion of said pilot portion and said panel portion against said bottom wall of said

annular groove, thereby deforming said panel portion radially and deforming said annular outer portion of said pilot portion against said panel portion, thereby entrapping said panel portion in said annular groove and sealing said female fastener on said panel.

5 6. The method of forming a sealed female fastener and panel assembly as defined in Claim 5, wherein said outer side wall of said annular groove is arcuately inclined toward said pilot portion, said method including deforming a second annular panel portion around said arcuately inclined outer side wall of said annular groove.

10 7. The method of forming a sealed female fastener and panel assembly as defined in Claim 5, wherein said method includes deforming said panel portion radially outwardly beneath said inclined outer side wall of said annular groove.

15 8. The method of forming a sealed female fastener and panel assembly as defined in Claim 5, wherein said method includes shaving a cylindrical end portion of said pilot portion and forming said annular outer portion of said pilot portion to form an annular arcuate portion deformed against said panel portion.

20 9. A sealed female fastener and panel assembly, comprising:
a female fastener element including an annular pilot portion having an end face, a bore through said pilot portion through end face, an annular flange portion surrounding said pilot portion having an annular end face parallel to said end face of said pilot portion and an annular groove in said flange portion having an annular bottom wall and relatively inclined annular side walls including an annular outer side wall inclined from adjacent said annular bottom wall radially inwardly toward said pilot portion and an inner side wall;

25 a panel including a first annular panel portion supported on said annular end face of said annular flange portion, a second integral annular panel portion deformed around said inclined annular outer side wall toward said annular bottom wall
30 and a third annular panel portion deformed against said bottom wall and extending to adjacent said annular inner side wall of said annular groove; and

WO 03/062651

-13-

PCT/US02/40278

said pilot portion including a cylindrical end portion above said third annular panel portion and an integral annular portion shaved from said pilot portion deformed against an inner opposed end portion of said third annular panel portion, whereby said inclined annular outer wall of said annular groove and said integral annular portion shaved from said pilot portion securely retains said female fastener on said panel portion in sealed relation.

10. The sealed female fastener and panel assembly as defined in Claim 9, wherein said integral annular portion shaved from said pilot portion includes an arcuate surface deformed against said third panel portion.

11. A self-attaching female fastener element, comprising:
a generally cylindrical pilot portion including an annular generally planar end face and a bore extending through said pilot portion through said end face;
an annular flange portion surrounding said pilot portion having a planar end face parallel to said end face of said pilot portion; and
an annular groove in said flange portion surrounding said pilot portion including an annular bottom wall, an annular inner side wall defining an outer surface of said pilot portion and an annular outer side wall, said annular inner side wall including an arcuate annular radially outwardly inclined surface adjacent said annular bottom wall and said annular outer wall arcuately inclined radially inwardly from said annular bottom wall toward said pilot portion to adjacent said annular end face of said flange portion.

12. The self-^{attaching} ~~piercing~~ female fastener element as defined in Claim ^{11,} wherein said pilot portion includes a generally cylindrical surface adjacent said end face of said pilot portion.

BEST AVAILABLE COPY

AMENDED SHEET